

## Effect of Breast Milk Lead on Infant Blood Lead Levels at 1 Month of Age

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Nursing infants may be exposed to lead from breast milk, but relatively few data exist with which to evaluate and quantify this relationship. This route of exposure constitutes a potential infant hazard from mothers with current ongoing exposure to lead as well as from mothers who have been exposed previously due to the redistribution of cumulative maternal bone lead stores. We studied the relationship between maternal breast milk lead and infant blood lead levels among 255 mother–infant pairs exclusively or partially breast-feeding through 1 month of age in Mexico City. A rigorous, well-validated technique was used to collect, prepare, and analyze the samples of breast milk to minimize the potential for environmental contamination and maximize the percent recovery of lead. Umbilical cord and maternal blood lead were measured at delivery; 1 month after delivery ( $\pm 5$  days) maternal blood, bone, and breast milk and infant blood lead levels were obtained. Levels of lead at 1 month postpartum were, for breast milk,  $0.3\text{--}8.0 \mu\text{g/L}$  (mean  $\pm$  SD,  $1.5 \pm 1.2$ ); maternal blood lead,  $2.9\text{--}29.9 \mu\text{g/dL}$  (mean  $\pm$  SD,  $9.4 \pm 4.5$ ); and infant blood lead,  $1.0\text{--}23.1 \mu\text{g/dL}$  (mean  $\pm$  SD,  $5.5 \pm 3.0$ ). Infant blood lead at 1 month postpartum was significantly correlated with umbilical cord (Spearman correlation coefficient  $r_S = 0.40$ ,  $p < 0.0001$ ) and maternal ( $r_S = 0.42$ ,  $p < 0.0001$ ) blood lead at delivery and with maternal blood ( $r_S = 0.67$ ,  $p < 0.0001$ ), patella ( $r_S = 0.19$ ,  $p = 0.004$ ), and breast milk ( $r_S = 0.32$ ,  $p < 0.0001$ ) lead at 1 month postpartum. Adjusting for cord blood lead, infant weight change, and reported breast-feeding status, a difference of approximately  $2 \mu\text{g/L}$  (ppb; from the midpoint of the lowest quartile to the midpoint of the highest quartile) breast milk lead was associated with a  $0.82 \mu\text{g/dL}$  increase in blood lead for breast-feeding infants at 1 month of age. Breast milk lead accounted for 12% of the variance of infant blood lead levels, whereas maternal blood lead accounted for 30%. Although these levels of lead in breast milk were low, they clearly have a strong influence on infant blood lead levels over and above the influence of maternal blood lead. Additional information on the lead content of dietary alternatives and interactions with other nutritional factors should be considered. However, because human milk is the best and most complete nutritional source for young infants, breast-feeding should be encouraged because the absolute values of the effects are small within this range of lead concentrations. **Key words:** blood lead, breast milk lead, breast-feeding, KXRF bone lead, lactation. *Environ Health Perspect* 112:1381–1385 (2004). doi:10.1289/ehp.6616 available via <http://dx.doi.org/> [Online 11 May 2004]

Breast milk has been suggested as a significant potential source of lead exposure to nursing infants (Silbergeld 1991), but relatively few data exist with which to evaluate and quantify this relationship. This phenomenon constitutes a potential public health problem in countries where environmental lead exposure is continuing as well as in countries where environmental lead exposure has declined (Abadin et al. 1997). Previously, we reported that maternal blood and bone lead levels are both important determinants of lead in breast milk (Ettinger et al. 2004). Lead from current maternal exposure, as well as that accumulated in bone from past environmental exposures and subsequently released into blood, is excreted into breast milk and thus may be ingested by the nursing infant.

Studies of lead in human milk have found concentrations ranging over three levels of magnitude from  $< 1$  to  $> 100 \mu\text{g/L}$  (ppb)

(Gulson et al. 1998; Namihiwa et al. 1993). However, there are limited epidemiologic data available regarding the potential exposure that this represents for the breast-feeding infant.

There are some data from rodents on the lactational transfer and uptake of lead in the newborn. Kostial and Momcilovic (1974) showed that the peak transfer of radiolabeled lead in mice from mother to litter occurred during lactation. Keller and Doherty (1980) found that 25% of maternal bone lead burden in mice was transferred to infant mice, and most of this activity occurred during lactation. Mouse breast milk was found to concentrate lead at around 25 times the level circulating in plasma. Amount of lead transferred seems to vary considerably by species (Oskarsson et al. 1995); however, there may be more efficient absorption of lead by the neonate compared with the adult (Oskarsson et al. 1998; Palminger Hallén et al. 1996).

In humans, Rabinowitz et al. (1985) described a log-linear dose–response relationship between breast milk lead and infant blood lead at 6 months of age ( $\beta = 3.0 \mu\text{g/dL}$ , SE =  $1.1 \mu\text{g/dL}$ ,  $r^2 = 10\%$ ,  $p = 0.009$ ). By examining the lead isotopic ratios in a small number of infants born to recent immigrants to Australia (and infants of Australian controls), Gulson et al. (1998) found that for the first 60–90 days postpartum the contribution from breast milk to blood lead in the infants varied from 36 to 80%.

We evaluated the effect of breast milk lead on infant blood lead levels to quantify the dose–response relationship in a large, population-based sample of infants exclusively or partially breast-fed through 1 month of age. We used a rigorous, well-validated technique to collect, prepare, and analyze the samples of breast milk to minimize the potential for contamination and maximize the percent recovery of lead.

### Materials and Methods

We conducted a cross-sectional study of 255 nursing infants at 1 month postpartum in Mexico City. Subjects included infants born to a subcohort of women recruited for later participation in a randomized placebo-controlled trial of calcium supplementation during lactation. Informed consent, questionnaire information, and samples for the present

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